

TRANSMITTAL SHEET

EXPRESS MAIL No.: EM 165 843 122 US

Deposited: July 9, 1998

I hereby certify that this correspondence is being deposited with the United States Postal Service Express Mail under 37 CFR 1.10 on the date indicated above and is addressed to: Assistant Commissioner for Patents, Washington, DC 20231

07/09/98

09/12/98

07/09/98

Assistant Commissioner for Patents
Washington, DC 20231

/ Ruth Montalvo

Date: July 9, 1998

Docket No: MOON-MS9802

Transmitted herewith for filing is the patent application in the name(s) of:
Jong-Deuk MOON, Hae Kwang KIM and Joo-Hee MOON

FOR: **APPARATUS AND METHOD FOR INTERPOLATING BINARY PICTURES,
USING CONTEXT PROBABILITY TABLE**

ENCLOSED ARE:

- (X) Specification (32 pages), 23 Claims (13 pages) & Abstract;
- (X) Figs. 1 - 11 / Nine (9) sheet(s) of Drawings;
- () Declaration and Power of Attorney; **TO FOLLOW**
- () Assignment to: *Hyundai Electronics Ind. Co., Ltd.*
- () Certified copy(ies) of Korean Pat. Appli. No. 97-31813 filed July 9, 1997, the priority(ies) of which is(are) claimed under 35 USC 119;
- () Verified Statement to establish Small Entity Status (37 CFR 1.9 & 1.27);
- () Information Disclosure Statement, PTO-1449 and ___ reference(s);

THE FILING FEE HAS BEEN CALCULATED AS SHOWN BELOW:

	Claims filed		Extra	SMALL \$ 395.00	LARGE \$ 790.00	AMOUNT \$ 790.00
Total Claims	23	Minus 20	3	x \$ 11.00	x \$ 22.00	\$ 66.00
Independent	4	Minus 03	1	x \$ 41.00	x \$ 82.00	\$ 82.00
Multiple dependent claim fee				+ \$ 135.00	+ \$ 270.00	\$.00
CHECK ENCLOSED:						\$ 938.00

The Commissioner is hereby authorized to charge any additional fees associated with the filing of this application but not limited to: (X) Any patent application processing fees under 37 CFR 1.17
(X) Any filing fees under 37 CFR 1.16 for the presentation of extra claims
and any other fees required with this submission or to credit any overpayment to Deposit Account No. 13-0025.

Respectfully submitted

JHN:ram

Harold Nissen
Harold Nissen - Reg. No. 17,283

APPARATUS AND METHOD FOR INTERPOLATING BINARY PICTURES, USING

CONTEXT PROBABILITY TABLE

BACKGROUND OF THE INVENTION

Field of the Invention

5 The present invention relates to an interpolation of binary pictures, and more particularly, to an apparatus and method for interpolating binary picture information based on a context probable table, namely, by employing a context probable value of a context based-arithmetic encoding.

10 Discussion of Related Art

There is some difference between an original picture and a picture down-sampled and up-sampled after the down-sampling in case that the binary picture information is down sampled and then up sampled in performing a loss coding for picture

information for the sake of a compression of binary picture information. Thus, in a process of the loss coding a picture of down-sampled small size is coded and a decoder decodes the picture of the small size to thereby perform an up-sampling
5 for the picture in an original size. The loss coding is executed like this through the down and up sampling process. In the up-sampling process, a binary picture block of 4x4 or 8x8 having a low resolution is converted into a sampled binary picture block of 16x16 having a high resolution, by applying
10 an interpolation to the up-sampling process.

There is presented a linear interpolating method, as a regularity of the existed interpolation process, in the Verification Model (VM) 8.0 described on WG11 under the ISO/IEC. In such linear interpolation method, in case the
15 interior of an object is as '1' and the exterior of the object is as '0', and also in case that A, B, C and D in Fig. 1 are as known values, values of P1, P2, P3 and P4 should be decided. The P1, P2, P3 and P4 in Fig. 1 are pixels to be interpolated.

In such process, the values of P1, P2, P3 and P4 are decided by the following method.

P1 : if $(2*A+B+C+D > 2)$ then '1' else '0'

P2 : if $(A+2*B+C+D > 2)$ then '1' else '0'

5 P3 : if $(A+b+2*C+D > 2)$ then '1' else '0'

P4 : if $(A+B+C+2*D > 2)$ then '1' else '0'

That is to say, in P1, a value of pixel A most neighboring to P1 is multiplied by 2, then added to the rest known pixels, B, C and D, and then if its sum is more than 2, P1 becomes as '1', if not, P1 is as '0'. In P1, P2, P3 and P4, a value of pixel B, C or D most neighboring to P2, P3 or P4 is respectively multiplied by 2, then each of the multiplied values is added to the rest known pixels and then if its sum is more than 2, it becomes as '1', if not, P1 is as '0'.

15 '0'.

In such conventional linear interpolation method, among pixels neighboring to an interpolating pixel, the number of

pixels such as the interior of an object is compared to the number of pixels such as the exterior of the object, it is decided according to more number in the comparison result whether or not it is the interior of the object or the

5 exterior of the object. In order to use more accurate method, there is provided a method that nearer pixel more influences upon the interpolating pixel according to an additional value based on a distance between the interpolating pixel and referring adjacent pixels.

10 Such linear interpolating method is to interpolate the picture information by considering the number of the interior and exterior pixels of four pixels adjacent to a coding pixel and multiplying its nearest pixel by 2. A correlation in such linear interpolating method is not accurate. Thus,

15 considering that the correlation among pixels of neighboring natural pictures is high, using a statistical method capable of characterizing numerically the correlation among respective pixels is a method for performing more accurate interpolation, in case that a functional relation representing such

correlation can not be defined.

In the context-based arithmetic encoding, a probability which pixels of a coding binary picture can have a value of '0' or '1', may be gotten by using pixels neighboring to a coding pixel. Namely, in case the coding pixel is '0', a probability that a current pixel may be '0' is experimentally gotten according to a distribution of the neighboring pixels. The arithmetic encoding is performed by employing such probability.

10 In order to get probable value of current pixels through a use of adjacent pixels, it is constructed context templates for deciding what adjacent pixels at which positions are used, to thereby get the probable values for the respective context templates.

15 Figs. 2(a) and 2(b) show one embodiment of context templates.

Supposing in Fig. 2(a) that parts of oblique lines are pixels for unknown values and checkered parts are '1' in its value, values of context indexes C_s may be obtained by the

following, e.g.,

$$\begin{aligned}C &= C_6*2^6+C_5*2^5+C_4*2^4+C_3*2^3+C_2*2^2+C_1*2^1+C_0*2^0 \\&= 0*2^6+1*2^5+0*2^4+1*2^3+1*2^2+0*2^1+1*2^0 \\&= 45\end{aligned}$$

5 The probable values are in general floating values
between 0 and 1, but there is much difficulty to process the
floating values between 0 and 1 by using only software and
hardware. The floating values between 0 and 1 are thus
normalized to integer values, then used. Namely, the values
10 between 0 and 1 are normalized to integer values between 1 and
65535. The number of arrayals constituting the probable table
is decided by the number of pixels constituting a context
template. If the number of pixels constituting the context
template is N, the number of probable values is as 2^N . In
15 horizontal and vertical contexts used for scalable binary
picture information, as shown in Figs. 2(a) and 2(b), each of
templates is constructed by 7 pixels, the number of the

probable values thus is 128. Meanwhile, referring to the probable table on the ISO/IEC WG11 VM 8.0, it has the number of 256 for the probable values. Therefore, the first number of 128, context indexes from 0 to 127, is for the probable values of horizontal context template, and the rest number of 128, context indexes from 128 to 255, is for the probable values of vertical context template.

Accordingly, as a calculating result by the aforementioned expression, the context index C in Fig. 2(a) is 45, it is thus read an index value 45 on the probable table for the calculated context index. Namely, the probable table is constructed such as `scalable_shape_intra[256] = {65476, 64428,, 2412, 35}` on the ISO/IEC WG11 VM 8.0, and in reading the probable values, values between 0 and 127 are used in the horizontal interpolation and then values between 128 and 255 are used in the vertical scanning. In such a case, the `scalable_shape_intra[45]` may become the probable value for the above-mentioned context. For such a value, when the value is read from the probable table of VM 8.0 presented on ISO/IEC

WG11, the value becomes '22794'. Since '22794' is the probable value for a probability of the exterior of an object, a probable value for the interior of object becomes '65535-22794=42741'.

5 Such probable value is previously decided and commonly stored at coding and decoding apparatuses, and coding data using coded probable value is transmitted to the decoding apparatus. The decoding apparatus decodes the probable value for the received data.

10 As afore-mentioned, in a case of utilizing the context probable table used in the CAE, more accurate interpolation can be achieved than a conventional linear interpolation method. In using the context probable table used in the CAE coding method, when many experimental pictures have the same
15 contexts for respective contexts, the number of cases that its pixels are as the interior and the exterior of an object, is checked in order to get a probability for which each of the contexts is as the interior of the object. In such context probable table, thus, the probable table is made not only

including the number of pixels as the interior of object and
pixels as the exterior of object, in adjacent pixels, but also
including information for positions and a correlation. That
is, the method for using such context probable table is to
5 interpolate more accurately than the method for using only the
number of pixels as the interior and exterior of the object of
neighboring pixels.

SUMMARY OF THE INVENTION

Accordingly, the present invention is directed to an
10 apparatus and method for interpolating binary picture
information that substantially obviates one or more of the
limitations and disadvantages of the related art.

An object of the present invention is to provide an
apparatus and method for interpolating binary picture
15 information by using a context probable table, which is
capable of together considering a distance between pixels,
positions of pixels and a sort of neighboring pixels through a
use of the context probable table of the CAE.

Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages
5 of the invention will be realized and attained by the structure as illustrated in the written description and claims hereof, as well as the appended drawings.

To achieve these and other advantages, and in accordance with the purpose of the present invention as embodied and
10 broadly described, binary picture information is divided into blocks of a given size and a bordering on the divided blocks is executed by using its adjacent blocks. In case that a corresponding block belongs to the uppermost or leftmost block of the inputted binary picture information, the uppermost row
15 or the leftmost column of the corresponding block is copied and a bordering on it is performed. A context template is constructed by employing pixels neighboring to coding pixels of a corresponding block. Values of indexes are also gained through a use of the constructed template, and a probability

for the indexes is read on a probable table. Probability as the exterior of an object and the interior of object is gained from the read probability, and its two values are compared with each other. If the probability as the interior of object is more than that of the exterior of object, an interpolation is performed with the interior value of object. If the probability as the exterior of object is more than that of the interior of object, an interpolation is performed with the exterior value of object.

10 It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE ATTACHED DRAWINGS

15 The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description

serve to explain the principles of the invention.

In the drawings:

Fig. 1 shows an explanation diagram providing a linear interpolation process applied in an up-sampling of binary picture information.

Figs. 2(a) and 2(b) represent one embodiment of a context template applied to the binary picture information.

Fig. 3 sets forth the construction for one preferred embodiment of an inventive interpolating apparatus.

Fig. 4 depicts a method for bordering pixels of a neighboring block in order for constructing a context of pixels corresponding to the leftmost column and the uppermost row of a current block.

Fig. 5 offers a method for bordering a block positioned on the uppermost or leftmost side of a binary picture.

Fig. 6 illustrates the construction for one embodiment of a bordering sector in accordance with the present invention.

Fig. 7 presents one embodiment of an inventive horizontal

and vertical interpolating sector.

Figs. 8(a) and 8(b) are explanatory diagrams showing horizontal and vertical interpolation processes.

Fig. 9 indicates a flow chart providing an interpolating
5 method in the invention.

Fig. 10 is a flow chart showing an inventive bordering
process.

Fig. 11 presents a flow chart for horizontal and vertical
interpolating processes in the present invention.

10 DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

Reference will now be made in detail to the preferred
embodiments of the present invention, examples of which are
illustrated in the accompanying drawings.

Fig. 3 shows one embodiment with the construction of an
15 inventive interpolating apparatus.

A block dividing sector 31 divides binary picture
information into blocks of a given size, e.g., 16x16, 8x8,
etc. A bordering sector 32 executes a bordering on blocks

outputted from the block dividing sector 31. A horizontal
interpolating sector 33 horizontally interpolates pixels of
the blocks outputted from the bordering sector 32. A vertical
interpolating sector 34 vertically interpolates pixels of the
5 blocks outputted from the horizontal interpolating sector 33.

Binary picture information of an object is divided into
blocks of a given size in the block dividing sector 31. These
blocks are bordered with columns and rows of blocks adjacent
to its left, upper and upper-left sides in the bordering
10 sector 32. In an interpolating process, a context template is
constructed with pixels neighboring to an interpolating pixel
as shown in Figs. 2(a) and 2(b), and its context indexes are
calculated. Such context template is presented on the VM of
the ISO/IEC WG11.

15 As shown in Figs. 2(a) and 2(b), the horizontal and
vertical contexts for respective pixels are constructed, and
context indexes C are computed. In case pixels adjacent to a
current pixel form a context like the above, there may be
constructed 2^7 kinds of contexts according to a distribution of

pixel values constituting the context.

The 2^7 kinds of contexts and its probable values constituting respective contexts correspond with each other in one to one by the indexes C gained by the following expression

5 (1).

$$C = \sum_{i=0}^6 C_i \cdot 2^i \dots \dots \dots (1)$$

In a process for gaining a probable value, it is progressed that a context is constructed as shown in Figs. 2(a) and 2(b), and a value of context index is gotten through the above-mentioned expression (1), and a probable value P_i corresponding to the index is read on a context probable table. Such a probable value is a probability for the interior of an object, and according to a size of the value, '0' indicating the exterior of object or '1' indicating the interior of object is selected.

15 In the context template constructing process as the

above, a context template for outermost pixels positioned on the left and upper sides of a current block can not be constructed as shown in Figs. 2(a) and 2(b). In other words, when the leftmost column is interpolated in the horizontal
5 interpolating process, there are no pixels corresponding to C0, C3 and C5 of Fig. 2(a), and when the uppermost row is interpolated, there are no pixels corresponding to C0, C1 and C2 of Fig. 2(a). In the vertical interpolating process, also, for the leftmost column there are no pixels corresponding to
10 C0, C3 and C4 of Fig. 2(b), and when the uppermost row is interpolated, there are no pixels corresponding to C0, C1 and C2 of Fig. 2(b).

Thus, in order to interpolate pixels corresponding to the leftmost column and uppermost row of a current block, a
15 bordering should be done before the interpolation. As shown in Fig. 4, pixel values of corresponding positions in an adjacent block are brought and the brought pixel values construct such required pixels, and such a process is said as a bordering.

In order to construct a context of pixels corresponding to the leftmost column and uppermost row of a current block, the pixels in the adjacent block are bordered on the current block as shown in Fig. 4. Since blocks positioned on the outermost side of an inputted binary picture have not neighboring blocks, its own leftmost column and uppermost row are copied on the right and left sides in executing the bordering.

The bordering process is described more in detail as follows.

First, in case the current block 41 is not the uppermost block and the leftmost block of binary picture, namely, in case blocks on its upper and left sides exist, a top border 42 is made with the lowermost row of a top block 45 neighboring to the upper side of the current block 41, and a left border 43 is made with the rightmost column of a left block 47 adjacent to the left of the current block 41. A corner border 44 is constructed with the rightmost-lowermost pixel value near to the top-left side of the current block 41.

Next, in other case, namely, in case a current block 41 is the uppermost or leftmost block of the inputted binary picture, referring to Fig. 5 there is illustrated a method for bordering a block positioned on the uppermost or leftmost side of the binary picture. If the current block is the uppermost block, a pixel value of a top block can not be used for the bordering as afore-mentioned since a block does not exist on the top side.

A top border 52 is constructed by copying the uppermost row of a current block 51, which represents pixels known before an up-sampling and shown in a checkered type on a second row of Fig. 5. On the copied top border 52, pixels for unknown values 521, 521,... among pixels for known values 522, 522,... are constructed by copying the known pixels 522, 522.. positioned on its right or left side.

If the current block is the leftmost block of the inputted binary picture, a left border 53 is constructed by utilizing known pixels before an up-sampling, which are presented as a checkered type in Fig. 5, on the leftmost

column of the current block 51, which are pixels known before the up-sampling and shown in a checkered type on a second column of Fig. 5. Pixels for unknown values 531, 531,... among pixels for known values 532, 532,... are constructed by copying the known values of pixels 532, 532.. positioned on its top or lower side. Like this, in case the current block is the leftmost or uppermost side of the inputted binary picture, the corner border may be determined as a value of '0' or '1'.

Meanwhile, in case pixels on the rightmost column of the current block or on its lowermost side are interpolated, a context template for the rightmost and lowermost pixels of the current block can not be formed as shown in Figs. 2(a) and 2(b). Namely, there are no pixels corresponding to C5 and C6 of Fig. 2(a) in case the lowermost row is interpolated in a horizontal interpolating process. In a vertical interpolating process, there are no pixels corresponding to C2 and C6 of Fig. 2(b) in case the rightmost row is interpolated. In this case, but, the bordering is not executed, a voluntary value is

determined by a software, to thereby construct a context template, in a context calculating part 71 mentioned later.

Fig. 6 provides one embodiment with the construction of an inventive bordering sector .

5 A block position detecting part 61 receives an address of a current block 41 from the inputted binary picture and detects a position of the current block 41. A copy part 62 receives the position of current block outputted from the block position detecting part 61 and borders on the top, top-
10 left and left side of the current block 41 in a block of a given size. A memory 63 stores blocks from the copy part 62 and outputs blocks 45, 46, 47 adjacent to the current block 41 to the copy part 62.

The block position detecting part 61 receives addresses
15 of pixels constituting the block inputted to the copy part 62, detects a position of the current block and outputs its position signal to the copy part 62. The copy part 62 detects by the inputted position signal whether or not a block position of the currently inputted binary picture belongs to

the uppermost or leftmost block.

As its detection result, in case it corresponds to the uppermost or leftmost block, the uppermost row or the leftmost column of the current block is copied on its left or top, to
5 thereby perform the bordering. For pixels for unknown values, namely, pixels before an up-sampling, 521, 521, ..., 531, 531,..., on the uppermost row or the leftmost column, the bordering is executed by copying pixels positioned on its right and left or its upper and lower sides as aforesaid.

10 If the current block does not correspond to the uppermost or leftmost block, as above-mentioned the top border 42 is made with the lowermost row of the top block 45 neighboring to the upper side of the current block 41, and the left border 43 is made with the rightmost column of the left block 47
15 adjacent to the left of the current block 41. The corner border 44 is constructed with the rightmost-lowermost pixel value near to the top-left side of the current block 41. Under such a bordered state, the horizontal and vertical interpolations are done.

Fig. 7 sets forth one embodiment of an inventive horizontal or vertical interpolating sector.

A shape context calculating part 71 receives the bordered block from the bordering sector 32, constructs a horizontal context shown in Fig. 2(a) for each of the pixels, and calculates context indexes. A probable table referring part 72 receives the context indexes from the context calculating part 71, reads probable values P_i corresponding to the indexes on a context probable table stored previously, and inputs the read values. A shape probability detecting part 74 detects whether or not the object interior probable value P_i read in the probable table referring part 72 is more than $1/2$ of probable maximum value. An interior/exterior interpolating part 75 interpolates binary information into the interior or exterior of an object in response to a detection signal outputted from the probability detecting part 74.

The construction of the horizontal interpolating sector 33 is equally applied to the vertical interpolating sector 34. In the horizontal interpolating sector 33, the context

calculating part 71 constructs the horizontal context shown in Fig. 2(a) and gets context indexes. In the vertical interpolating sector 34, the context calculating part 71 constructs the vertical context shown in Fig. 2(b) and gets context indexes.

A block bordered in the bordering sector 32 is inputted to the context calculating part 71, and the horizontal context shown in Fig. 2(a) is therein constructed for respective pixels constituting the current block, and then context indexes C are calculated.

By the way, in case that the context template shown in Fig. 2(a) is constructed in order to horizontally interpolate the rightmost column of the current block, an eighth column of the current block 51 shown in Fig. 5, and in case that the context template shown in Fig. 2(a) is constructed in order to horizontally interpolate the lowermost row of the current block, an eighth row of the current block 51 shown in Fig. 5, there are no pixels corresponding to C5 and C6. In the vertical interpolation, also, in case the context template for

the rightmost column of the current block 51 is constructed,
there are no pixels corresponding to C2 and C6 of Fig. 2(b).

However, the bordering for the rightmost column and the
lowermost row of the current block 51 is not executed in the
5 bordering sector 32, thus, the context calculating part 71
copies neighboring pixels or determines voluntary values
through the software, for parts that there do not exist
pixels, in constructing the context template shown in Figs.
2(a) and 2(b). The context template is constructed by such a
10 process in the context calculating part 71, to then get
context indexes.

The probable table referring part 72 reads and inputs the
probable value P_i that the current pixel may be the interior
of object, from the probable table stored according to the
15 context indexes. The probability detecting part 74 compares
the object interior probable value P_i read by the probable
table referring part 72 with $1/2$ of the maximum probable
value, and outputs a signal for interpolating with the object
interior value to the interior/exterior interpolating part 75

in case that the object interior probable value P_i is more than $1/2$ of the maximum probable value. In case that the object interior probable value P_i is less than $1/2$ of the maximum probable value, the probability detecting part 74 outputs a signal for interpolating with the object exterior value to the interior/exterior interpolating part 75. The interior/exterior interpolating part 75 interpolates the binary picture information into the interior or exterior of the object in response to a detection signal for interpolating with the interior or exterior value.

Fig. 8(a) depicts a block of 8×8 completed in a horizontal interpolating process.

Pixels shown in oblique lines in Fig. 8(a) are known previously before an interpolation, a context template of Fig. 2(a) for pixels shown in checkered design in Fig. 8(a) is made to get context indexes, a probable value for an object interior is gotten from a probable table by using the context indexes and interpolated into the interior or exterior of the object. In the horizontal interpolating process, the

horizontal context template of Fig. 2(a) from a pixel positioned on a second row and first column of the current block 51 is made, then the interpolation process is done successively in the right direction from that to an eighth row and seventh column of the current block 51. Interpolating from a pixel positioned on the top and left side like this has a reason why an order of a coding and decoding on pictures is executed from the left and upper side, thus pixel values of blocks on the upper and left side are known previously.

10 When the pixels of checkered design are gotten in the horizontal interpolating process in Fig. 8(a), pixels of checkered design in Fig. 8(b), pixels on first, third, fifth and seventh rows, are interpolated in the vertical interpolating process. In the vertical interpolating process, 15 the context template of Fig. 2(b) is constructed and the interpolation process is done successively in the right direction, from a pixel positioned on a first row and first column of the current block 51 to a pixel of the first row and second column,....., a pixel of the first row and eighth

column, a pixel of a third row and first column, ..., a pixel of a seventh row and eighth column.

Such interpolation in the right direction from the leftmost side of the current block is not only for a reason why the coding and decoding order of pictures is performed from the left and top side but also for a reason why the context template of Fig. 2(b) is constructed by using pixels positioned on the left side of the current pixel X.

Fig. 9 offers a flow chart showing an inventive interpolating method.

In a step ST901, binary picture information is divided into blocks of a given size, e.g., 16x16, 8x8, etc., and bordering blocks 52, 53 are bordered on the top and left sides of respective blocks 51. In a step ST902, a horizontal interpolation process is performed for pixels constituting the bordered block. In a step ST903, a vertical interpolation process is executed for blocks completed in the horizontal interpolation process. Herewith, it is not always necessary to execute the horizontal interpolation process first surely,

and there is not much difference even though the vertical interpolation first and the vertical interpolation next are done.

Fig. 10 is a flow chart providing a bordering process in accordance with the present invention.

In a step ST101, the binary picture information is divided into blocks of a given size, e.g., 8x8, etc. In a step ST102, a current block is extended in a given size. For instance, a block of 8x8 is extended into a block of 16x16, by selecting one pixel among 2x2 for pixels having known its value such as the blocks 41, 51 of Figs. 4 and 5 aforesaid. In a step ST103, it is detected whether or not one block is the uppermost block of the binary picture information. If it is the uppermost block, in a step ST104 the uppermost row of the current block is bordered on the top of the current block. If it is not the uppermost block, in a step ST105 the lowermost row of a block neighboring to the upper side of the current block is bordered on the top of the current block. In a step ST106, it is detected whether or not the current block

is positioned on the leftmost side of the binary picture. In case the current block is positioned on the leftmost side, in a step 107 the leftmost column of the current block is bordered on the left of the current block. In case the current block is not positioned on the leftmost side, in a step 108 the rightmost column in the left neighboring block of the current block is bordered on the left of the current block. In a step 109, a pixel on the rightmost and lowermost side of a block positioned on the top and left side of the current block is bordered on a corner of the top and left side of the current block.

Fig. 11 illustrates a flow chart showing horizontal and vertical interpolating processes in the invention.

In a step ST111, for respective pixels constituting the block bordered through a bordering process, the context template shown in Fig. 2(a) is made and context indexes are calculated. In a case of the vertical interpolation, the context template shown in Fig. 2(b) is used. In a step ST112, a probable value within an object, stored in the probable

table referring part 72, is read and inputs the read values thereto by using the context indexes gotten in the step ST111.

In a case of the vertical interpolation, the probable table referring part 72 is used. In a step ST113, it is detected

5 whether or not the probable value P_i is more than $1/2$ of the maximum probable value. Herewith, a case that the probable value for the object interior, P_i , is more than $1/2$ of the maximum probable value, represents that the probable value for the object interior, P_i , is more than the probable value for
10 the object exterior, P_o . If the probable value for the object interior, P_i , is more than $1/2$ of the maximum probable value, in a step ST115 a value of the current pixel is determined as '1' and this value is given as a pixel value of the object interior. If the probable value for the object interior, P_i ,
15 is less than $1/2$ of the maximum probable value, in a step ST114 a value of the current pixel is determined as '0' and this value is given as a pixel value of the object exterior.

In a description of the present invention as aforementioned, the invention was applied to a case of dividing

picture information into blocks of a given size. Meantime,
the present invention can be also performed by extracting a
video object plane (VOP) and applying the context index
calculation, a computation of a probable value, a comparison
5 of the probable values and exterior/interior interpolation
processes thereto, for pixels constituting the VOP. Further,
the unit for an interpolation may be a frame unit, a VOP unit,
or a macro block (MB) unit.

The practical field in employing the present invention
10 has an MPEG-4 scalable binary picture information coding. In
order to display a base layer in the MPEG-4 scalable binary
picture information coding, an interpolation process for
changing the base layer to a picture of a size such as that in
an enhancement is done. Since a CAE is utilized in coding the
15 enhancement layer at this time, the probable table for
respective contexts are arranged. Accordingly, in case that
the same contexts used for the scalable coding in the
interpolation process are employed, there is no need to make
separately the probable tables since the same probable table

can be utilized in the interpolation.

As above-mentioned, in accordance with the present invention, for an interpolating pixel a context template is made with its adjacent pixels, its context probable value is obtained, and probable values for the object interior and the object exterior are compared with each other. The binary picture information is then interpolated by a value provided from a case of more probable value as its comparison result, to thereby achieve an accurate interpolation.

It will be apparent to those skilled in the art that various modifications and variations can be made in the binary picture information interpolating method and apparatus of the present invention without deviating from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. A method for interpolating binary pictures by using context probable values in order to reconstruct the binary picture having low resolution as the picture having high

5 resolution through an up-sampling, said method comprising the steps of:

dividing said binary picture into a plurality of blocks;

extending the block to a size of the picture presented in the up-sampling;

10 detecting a position of said block on the binary picture;

bordering the block according to the detected block position;

forming a context template for an interpolating pixel in the bordered block;

15 getting indexes of the context template and obtaining a probability of said interpolating pixel from a context probable table through a use of the context indexes; and

deciding a value of the interpolating pixel based on the

context probable value of the interpolating pixel.

2. The method of claim 1, wherein said binary picture is divided into the blocks of 8x8.

3. The method of claim 1, wherein the position detecting
5 step detects whether or not said block is positioned on the leftmost or uppermost side of the binary picture.

4. The method of claim 1, wherein said bordering step comprises the steps of:

copying the uppermost row of a current block and thereby
10 forming a top border in case that said current block is the uppermost block of inputted binary picture, and copying known pixels positioned on the right or left of pixels for unknown values on said top border;

constructing a left border by using the leftmost column
15 of the current block in case that said current block is the leftmost block of the inputted binary picture and copying

known values of pixels situated on the upper or lower side of
pixels for unknown values on said left border;

determining a corner border as '0' or '1'; and

forming the top border with the lowermost row of upper

5 adjacent block, the left border with the rightmost column of
left block neighboring to the current block and the corner
border with a rightmost and lowermost pixel value of the left
or upper block adjacent to the current block, in case that
said current block is not the uppermost block and the leftmost
10 block of the inputted binary picture.

5. The method of claim 1, wherein the context template
forming step constructs the context template for a part having
no pixels by copying neighboring pixels or determining a
voluntary value, in case that it is formed in the bordered
15 block the context template for a pixel corresponding to the
current block and the context template for a pixel of the
rightmost column or lowermost row.

6. The method of claim 1, wherein said context probable table includes the probable values previously gained for all context templates and is commonly stored at coding and decoding apparatuses.

5 7. The method of claim 1, wherein a value of said interpolating pixel is determined as an interior value if the probable value for the interior is more than that for the exterior in said context probable value of said interpolating pixel, and is determined as an exterior value if the probable
10 value for the exterior is more than that for the interior therein.

8. A method for interpolating binary pictures by using context probable table in order to reconstruct the binary picture having low resolution as the picture having high
15 resolution through an up-sampling, said method comprising:

a first step for dividing said binary picture into blocks of a given size and extending the blocks to a size of the

picture up-sampled;

a second step for executing a bordering on the top and left side of respective extended blocks;

a third step for constructing a context template for each
5 of pixels for unknown values in the extended blocks and
calculating context indexes;

a fourth step for reading and getting, from the context
probable table, probable values of an object interior for the
respective pixels through a use of the context indexes gotten
10 in said third step;

a fifth step for detecting whether or not the probable
value for the object interior is more than that of an object
exterior; and

a sixth step for determining a value of a current pixel
15 as a pixel of the object interior if the probable value for
the object interior is more than that for the object exterior
and determining the value of the current pixel as a pixel of
the object exterior if the probable value for the object
interior is not more than that for the object exterior.

9. The method of claim 8, said method in a use of the context template including the steps of:

executing a horizontal interpolation by performing the third step to the sixth step through a use of a horizontal

5 context template; and

performing a vertical interpolation by executing the third step to the sixth step through a use of a vertical context template.

10. The method of claim 8, wherein the bordering process of said second step comprises the steps of:

detecting whether or not a current block is the uppermost block of the binary picture information;

bordering the uppermost row of the current block on the top of the current block in case that it is the uppermost block, and bordering the lowermost row of a block neighboring to the top of the current block upon the current block in case that it is not the uppermost block;

checking whether or not the current block is positioned

on the leftmost side of an object;

bordering the leftmost column of the current block on the
left side of the current block in case that it is situated on
the leftmost side, and bordering the rightmost column of a
5 block neighboring to the left side of the current block upon
the left side of the current block in case that it is not
situated on the leftmost side; and

bordering a left and upper corner of the current block.

11. The method of claim 8, wherein said third step copies
10 values of adjacent pixels and thereby interpolates, in case
that pixels constituting the context template are deviated
from the picture in gaining the context template of a
interpolating pixel.

12. The method of claim 8, wherein said third step forms
15 the context template for a part having no pixels by copying
neighboring pixels or determining a voluntary value, in case
that the context template for a pixel of the rightmost column

or lowermost row is constructed in gaining the context template of said interpolating pixel.

13. The method of claim 8, wherein said interpolating method is performed in a frame unit or a VOP unit.

5 14. The method of claim 10, wherein the corner bordering step borders a corner of the current block with the rightmost and lowermost pixel value of its left and top block if a block exists on the top and left side of the current block, and borders the corner with the exterior of the object if the
10 block does not exist on the top and left side of the current block.

15. An apparatus for interpolating binary pictures by using context probable table in order to reconstruct the binary picture having low resolution as the picture having
15 high resolution through an up-sampling, said apparatus comprising:

block dividing means for dividing said binary picture
into blocks of a given size;

bordering means for executing a bordering for blocks
outputted from said block dividing means;

5 horizontal interpolating means for interpolating
horizontally pixels of the blocks outputted from said
bordering means; and

vertical interpolating means for interpolating vertically
pixels of the blocks outputted from said horizontal
10 interpolating means.

16. The apparatus of claim 15, wherein said bordering
means performs the bordering with pixels brought from an
adjacent block of a current block.

17. The apparatus of claim 15, wherein said bordering
15 means comprises:

block position detecting means for receiving an address
of the current block on the inputted binary picture and

detecting a position of the current block;

copy means for receiving the position of the current
block outputted from said block position detecting means and
bordering the blocks of a given size on the top, left and
5 upper side and left side of the current block; and

memory for storing the blocks from said copy means and
outputting the neighboring blocks of the current block to said
copy means.

18. The apparatus of claim 15, wherein said horizontal
10 interpolation means and said vertical interpolation means
comprise:

context calculating means for receiving the bordered
blocks and calculating context indexes for respective pixels;

probable table referring means for receiving the context
15 indexes from said context calculating means, and reading and
getting probable values corresponding to the index on/from the
context probable table stored previously;

probability detecting means for detecting whether or not

the probable value for an object interior read and gotten
on/from said probable table referring means is more than 0.5;
and

interior/exterior interpolating means for interpolating
5 an object interior value or an object exterior value for the
respective pixels on the bordered block in response to a
detection result signal of said probability detecting means.

19. The apparatus of claim 15, wherein said bordering
means copies its own leftmost column and uppermost row on the
10 top and left side of the block to thereby perform a bordering,
for the blocks situated on the object.

20. The apparatus of claim 18, wherein said copy means
borders with the rightmost and lowermost pixel value of its
left and top block if a block exists on the top and left side
15 of the current block, and borders with the exterior of the
object if the block does not exist on the top and left side of
the current block.

21. The apparatus of claim 18, wherein said probability detecting means compares the probable value of the object interior read and gotten from said probable table referring means with 0.5; controls so that said interior/exterior

5 interpolating means interpolates the respective pixels of the bordered block as the object interior value, in case the probable value of the object interior is more than 0.5; and controls so that said interior/exterior interpolating means interpolates the respective pixels of the bordered block as
10 the object exterior value, in case the probable value of the object interior is less than 0.5.

22. The apparatus of claim 16, wherein said bordering means copies its own leftmost column and uppermost row on the top and left side of the block to thereby perform a bordering,
15 for the blocks situated on the object.

23. An apparatus for interpolating binary pictures by using context probable table in order to reconstruct the

binary picture having low resolution as the picture having high resolution through an up-sampling, said apparatus comprising:

VOP extracting means for dividing said binary picture

5 information into VOPs;

bordering means for extending the VOP outputted from said

VOP extraction means to a size in the up-sampling and performing a bordering;

horizontal interpolating means for horizontally

10 interpolating pixels of the VOP outputted from said bordering means; and

vertical interpolating means for vertically interpolating pixels of the VOP outputted from said horizontal interpolating means.

Abstract of Disclosure

A context probable table of context template is employed in order to interpolate binary picture information. The context template for respective pixels making up the binary picture information is made, and probabilities for the interior of an object and the exterior of the object on its context indexes are obtained from the context probable table arranged previously. The probabilities for the interior and exterior of the object are compared with each other and the binary picture information is interpolated with a value having more probability.

FIG. 1

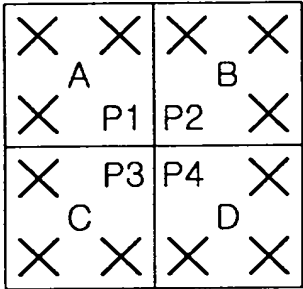
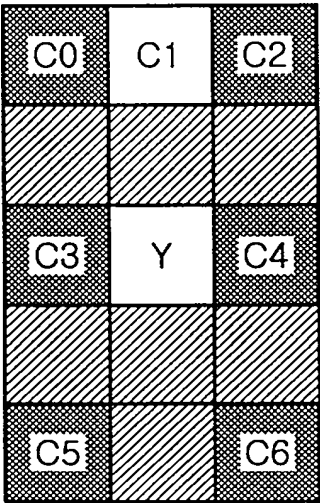


FIG. 2

(a) Horizontal



(b) Vertical

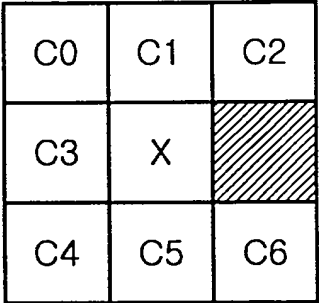


FIG. 3

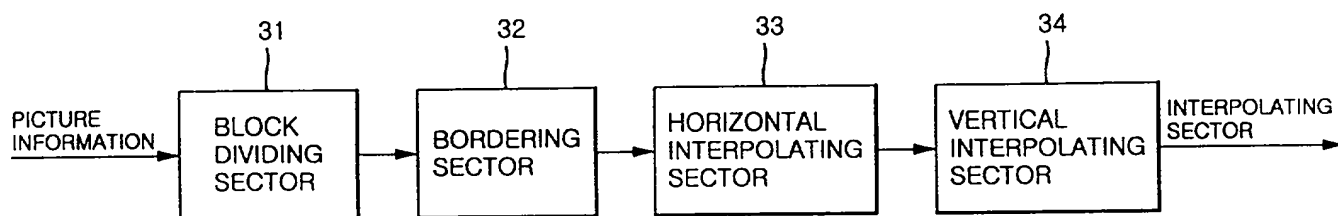


FIG. 7

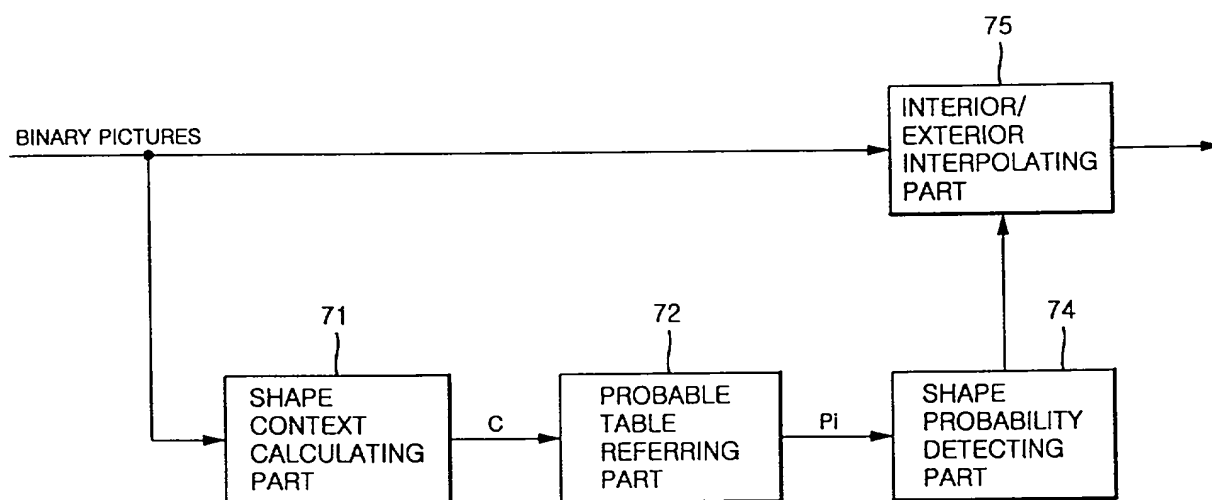


FIG. 4

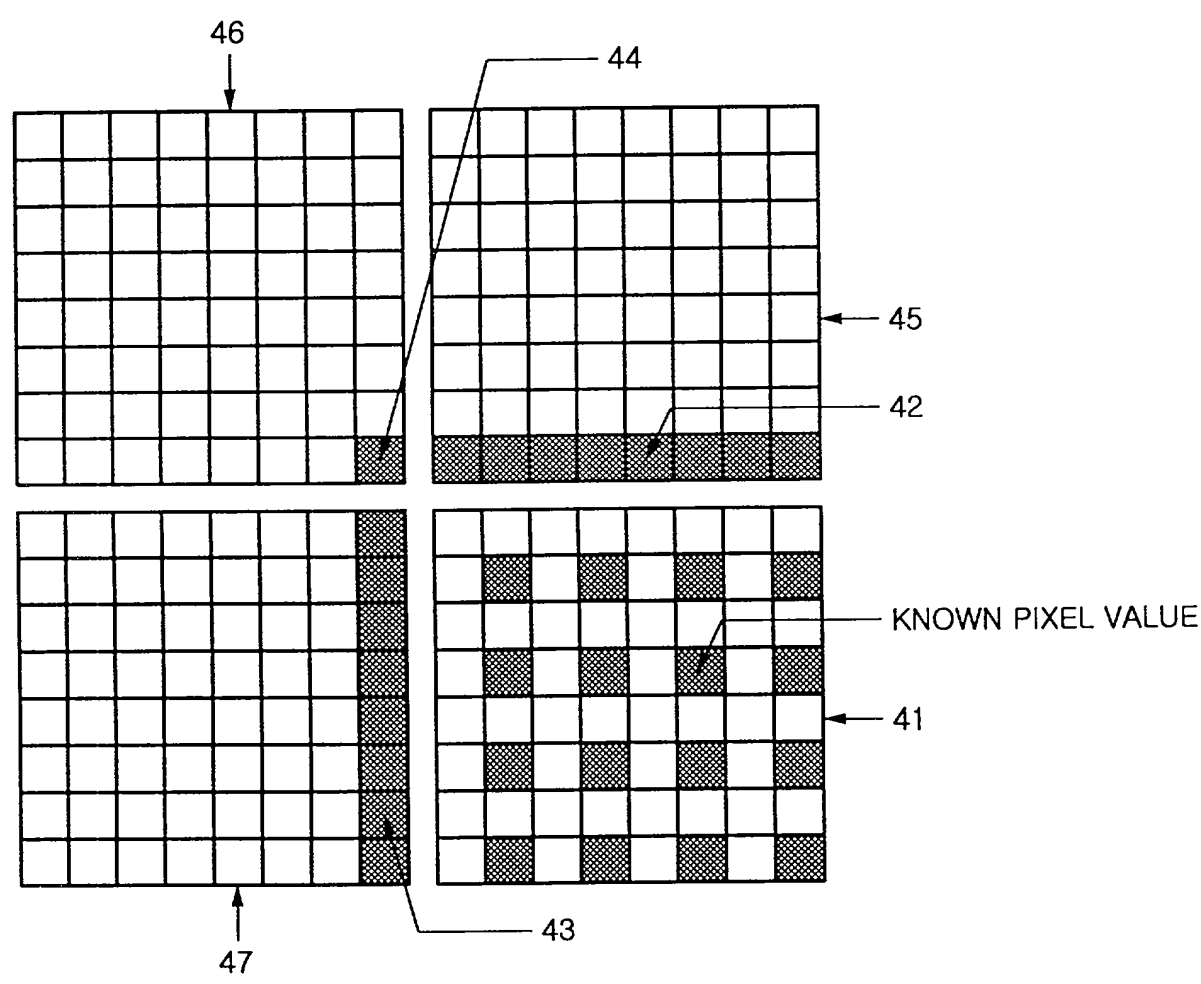


FIG. 5

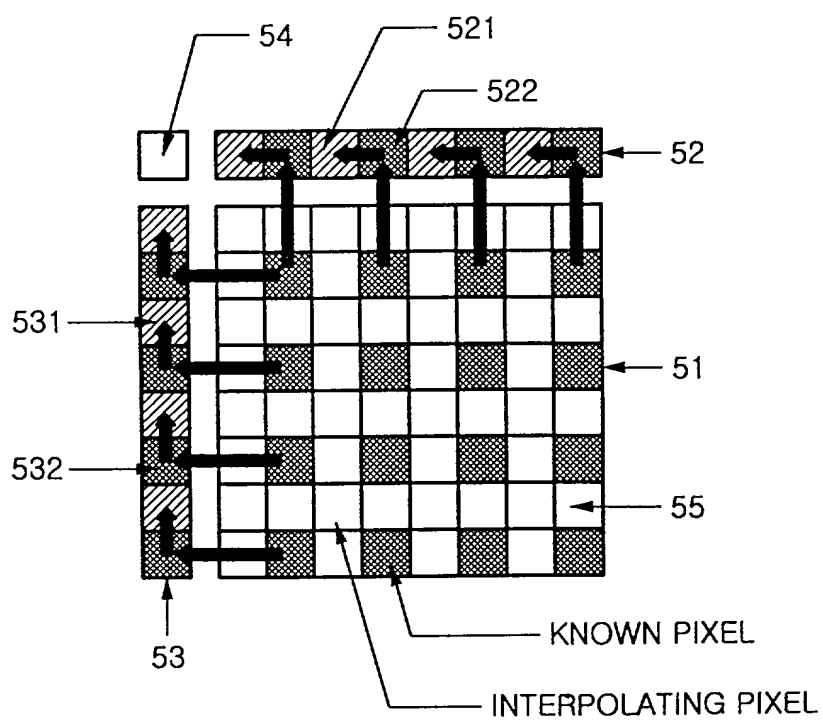
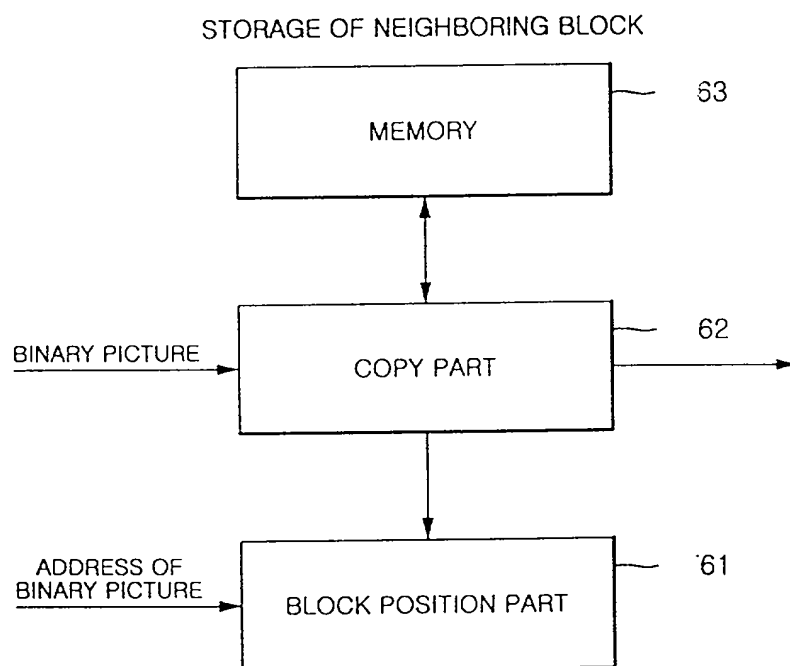
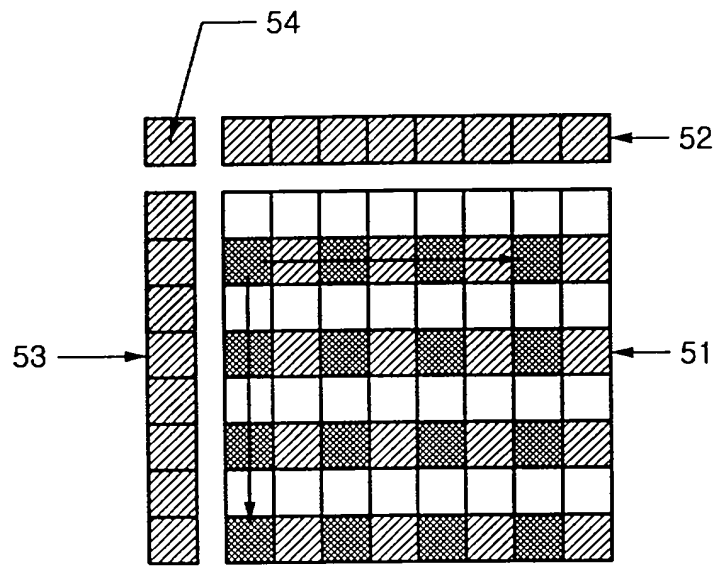


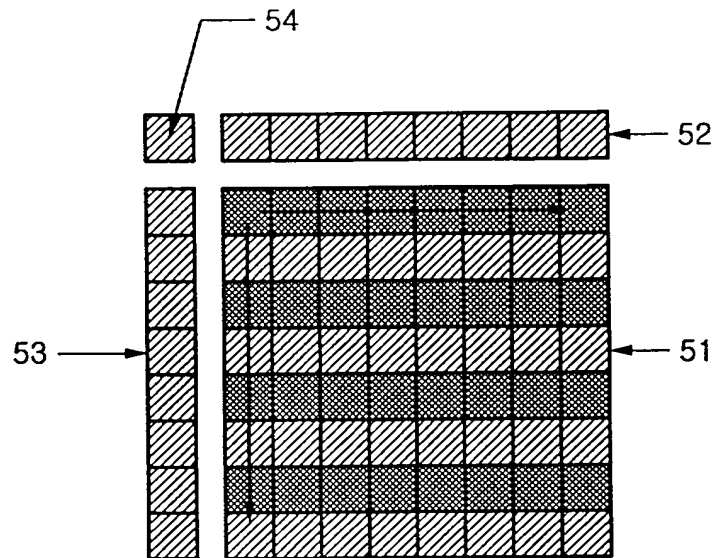
FIG. 6



Case	Age	Sex	Site	Pathologic	Survival
1	65	M	Rectum	Adenocarcinoma	10 years
2	68	F	Rectum	Adenocarcinoma	12 years
3	72	M	Rectum	Adenocarcinoma	15 years
4	75	F	Rectum	Adenocarcinoma	18 years
5	78	M	Rectum	Adenocarcinoma	20 years
6	80	F	Rectum	Adenocarcinoma	22 years
7	82	M	Rectum	Adenocarcinoma	25 years
8	85	F	Rectum	Adenocarcinoma	28 years
9	88	M	Rectum	Adenocarcinoma	30 years
10	90	F	Rectum	Adenocarcinoma	32 years
11	92	M	Rectum	Adenocarcinoma	35 years
12	95	F	Rectum	Adenocarcinoma	38 years
13	98	M	Rectum	Adenocarcinoma	40 years
14	100	F	Rectum	Adenocarcinoma	42 years
15	102	M	Rectum	Adenocarcinoma	45 years
16	105	F	Rectum	Adenocarcinoma	48 years
17	108	M	Rectum	Adenocarcinoma	50 years
18	110	F	Rectum	Adenocarcinoma	52 years
19	112	M	Rectum	Adenocarcinoma	55 years
20	115	F	Rectum	Adenocarcinoma	58 years
21	118	M	Rectum	Adenocarcinoma	60 years
22	120	F	Rectum	Adenocarcinoma	62 years
23	122	M	Rectum	Adenocarcinoma	65 years
24	125	F	Rectum	Adenocarcinoma	68 years
25	128	M	Rectum	Adenocarcinoma	70 years
26	130	F	Rectum	Adenocarcinoma	72 years
27	132	M	Rectum	Adenocarcinoma	75 years
28	135	F	Rectum	Adenocarcinoma	78 years
29	138	M	Rectum	Adenocarcinoma	80 years
30	140	F	Rectum	Adenocarcinoma	82 years
31	142	M	Rectum	Adenocarcinoma	85 years
32	145	F	Rectum	Adenocarcinoma	88 years
33	148	M	Rectum	Adenocarcinoma	90 years
34	150	F	Rectum	Adenocarcinoma	92 years
35	152	M	Rectum	Adenocarcinoma	95 years
36	155	F	Rectum	Adenocarcinoma	98 years
37	158	M	Rectum	Adenocarcinoma	100 years
38	160	F	Rectum	Adenocarcinoma	102 years
39	162	M	Rectum	Adenocarcinoma	105 years
40	165	F	Rectum	Adenocarcinoma	108 years
41	168	M	Rectum	Adenocarcinoma	110 years
42	170	F	Rectum	Adenocarcinoma	112 years
43	172	M	Rectum	Adenocarcinoma	115 years
44	175	F	Rectum	Adenocarcinoma	118 years
45	178	M	Rectum	Adenocarcinoma	120 years
46	180	F	Rectum	Adenocarcinoma	122 years
47	182	M	Rectum	Adenocarcinoma	125 years
48	185	F	Rectum	Adenocarcinoma	128 years
49	188	M	Rectum	Adenocarcinoma	130 years
50	190	F	Rectum	Adenocarcinoma	132 years
51	192	M	Rectum	Adenocarcinoma	135 years
52	195	F	Rectum	Adenocarcinoma	138 years
53	198	M	Rectum	Adenocarcinoma	140 years
54	200	F	Rectum	Adenocarcinoma	142 years
55	202	M	Rectum	Adenocarcinoma	145 years
56	205	F	Rectum	Adenocarcinoma	148 years
57	208	M	Rectum	Adenocarcinoma	150 years
58	210	F	Rectum	Adenocarcinoma	152 years
59	212	M	Rectum	Adenocarcinoma	155 years
60	215	F	Rectum	Adenocarcinoma	158 years
61	218	M	Rectum	Adenocarcinoma	160 years
62	220	F	Rectum	Adenocarcinoma	162 years
63	222	M	Rectum	Adenocarcinoma	165 years
64	225	F	Rectum	Adenocarcinoma	168 years
65	228	M	Rectum	Adenocarcinoma	170 years
66	230	F	Rectum	Adenocarcinoma	172 years
67	232	M	Rectum	Adenocarcinoma	175 years
68	235	F	Rectum	Adenocarcinoma	178 years
69					



(a) HORIZONTAL INTERPOLATION



(b) VERTICAL INTERPOLATION

FIG. 9

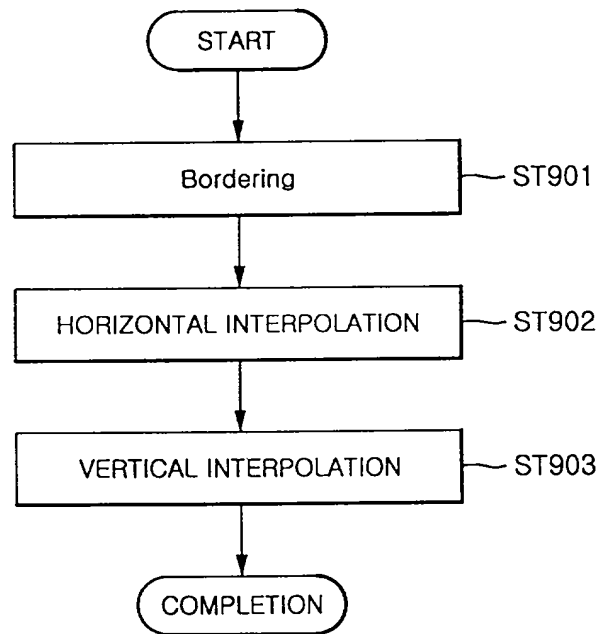


FIG. 10

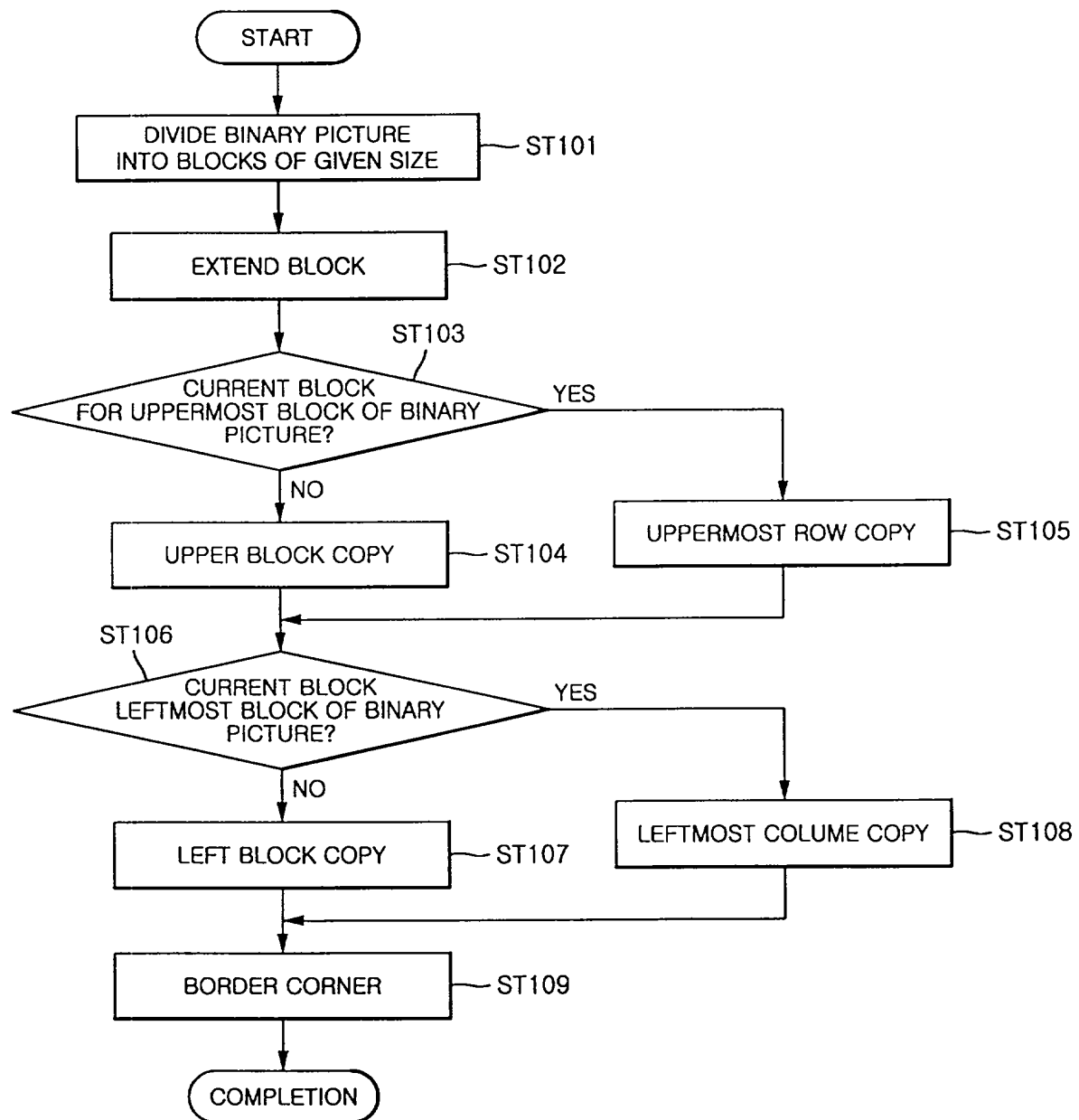
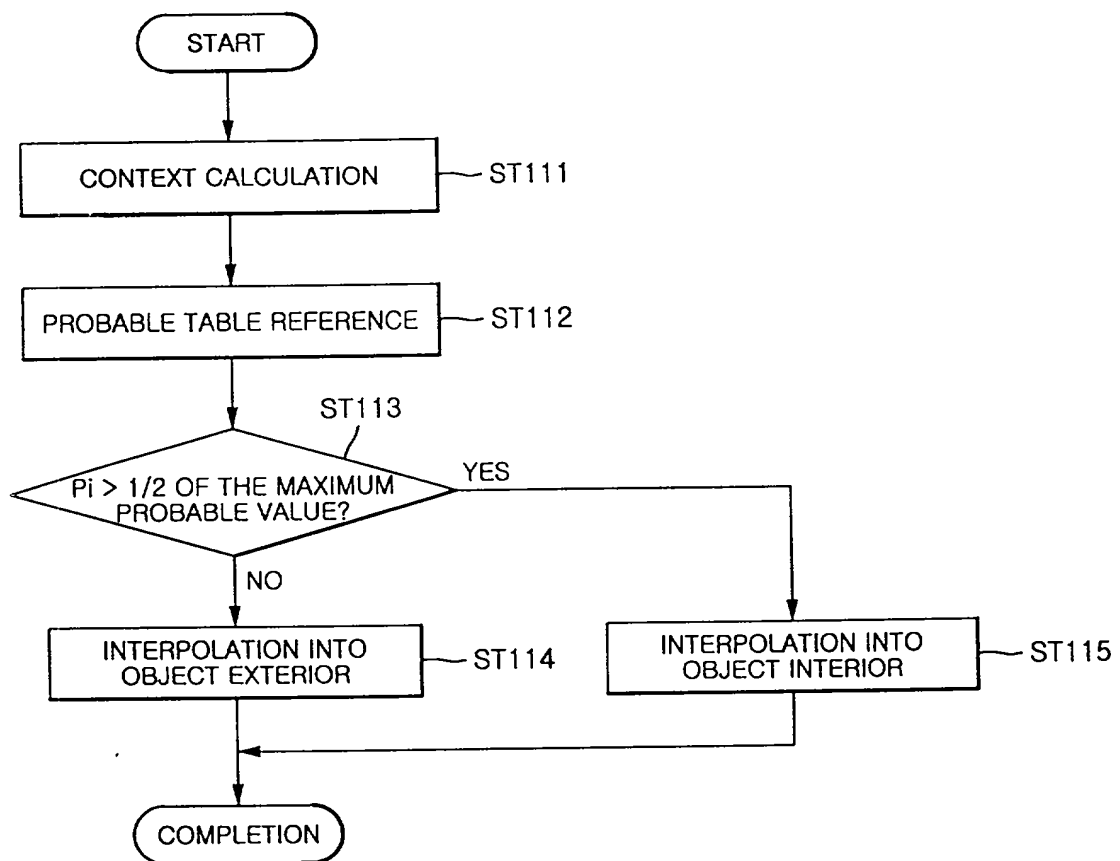
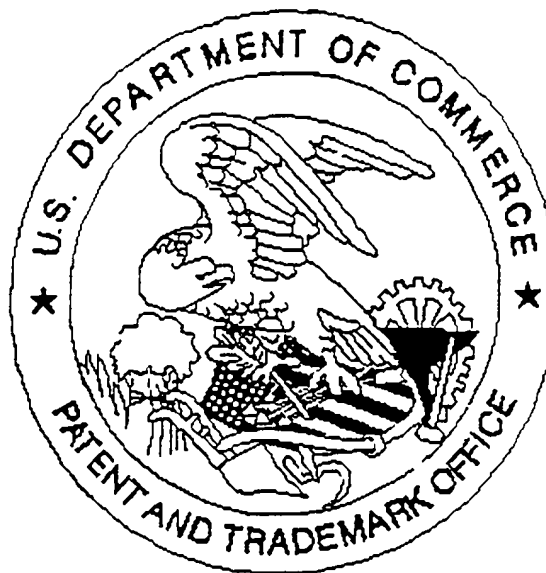


FIG. 11



United States Patent & Trademark Office

Office of Initial Patent Examination -- Scanning Division



Application deficiencies found during scanning:

1. Application papers are not suitable for scanning and are not in compliance with 37 CFR 1.52 because:
 - ☐ All sheets must be the same size and either A4 (21 cm x 29.7 cm) or 8-1/2" x 11". Pages _____ do not meet these requirements
 - ☐ Papers are not flexible, strong, smooth, non-shiny, durable, and white.
 - ☐ Papers are not typewritten or mechanically printed in permanent ink on one side.
 - ☐ Papers contain improper margins. Each sheet must have a left margin of at least 2.5 cm (1") and top, bottom and right margins of at least 2.0 cm (3/4")
 - ☐ Papers contain hand lettering.
2. Drawings are not in compliance and were not scanned because:
 - ☐ The drawings or copy of drawings are not suitable for electronic reproduction.
 - ☐ All drawings sheets are not the same size. Pages must be either A4 (21 cm x 29.7 cm) or 8-1/2" x 11".
 - ☐ Each sheet must include a top and left margin of at least 2.5 cm (1"), a right margin of at least 1.5 cm (9/16") and a bottom margin of at least 1.0 cm (3/8")
3. Page(s) _____ are not of sufficient clarity, contrast and quality for electronic reproduction.
4. Page(s) _____ are missing.
5. OTHER: No Declaration